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NEEDLE BLADE ROLL
FOR
ARTIFICIAL COTTON FABRICATING APPARATUS

TECHNICAL FIELD

The present invention relates to a needle blade roll for forming a large number of short fibers from a material capable of formation of a cotton-like substance (hereinafter artificial cotton) in an artificial cotton fabricating apparatus which fabricates artificial cotton by accumulation of such short fibers.

BACKGROUND ART

In this type of conventional artificial cotton fabricating apparatus such as the one shown in Figure 11, many (numerous) short fibers **(102)** ranging in fiber length between 1 to 200 mm are formed from a fiber material **(101)** in the form of a yarn, a sliver et cetera. These short fibers **(102)** are accumulated on an accumulation surface member (e.g., a mesh belt **(103)**, a base paper sheet et cetera) while causing the mesh belt **(103)**) to travel, and artificial cotton is fabricated successively (see for example Japanese Patent *Kokai* Publication No. 1997-193277). The fiber material **(101)** may be any type of material that is capable of formation of artificial cotton. As the fiber material **(101)**, various materials including synthetic resin have been used.

The artificial cotton fabricating apparatus **(100)** of this conventional type usually employs, as a means for forming short fibers **(102)** from the fiber material **(101)**, a needle blade roll **(106)** comprising a roll main body **(104)** and a large number of needle blades **(105)** implanted into the outer peripheral surface of the roll main body **(104)**. The needle blade roll **(106)** is mounted in the inside of a cylindrical casing **(107)** having a supply inlet for the fiber material **(101)** and a discharge outlet for the short fibers **(102)**, these openings being formed in a spaced apart relationship with each other in the circumferential direction.

The discharge outlet of the casing **(107)** opens to a wind channel **(108)** which is air-sucked from below. In addition, the mesh belt **(103)** and its forwarding mechanism (not shown) are arranged under the wind channel **(108)**.

In order to form a large number of short fibers **(102)**, in the apparatus **(100)** the fiber material **(101)** is fed through a very narrow clearance between the needle blade roll **(106)** and the casing **(107)** and, at the same time, the needle blade roll **(106)** is rotated at high speed. The short fibers **(102)** thus formed are dispersed in the wind channel **(108)**. And, the short fibers **(102)** dispersed in the wind channel **(108)** are intertwined with one another and are accumulated on the conveyor belt **(103)**. As a result, artificial cotton is fabricated.

Problems To Be Solved

And now, in the conventional needle blade roll **(106)**, each of the blade needles **(105)** is arranged on the circumferential surface of the roll main body **(104)** along the direction of a respective radial line thereof. Alternatively, each of the blade needles **(105)** is arranged at a sloping angle with respect to a respective radial-line direction so that its leading end is situated behind relative to the rotational direction of the needle blade roll **(106)**. Stated another way, the needle blades **(105)** are arrayed at right angles to the circumferential surface of the roll main body **(104)** or inclined backward.

However, in the case where such a conventional needle blade roll **(106)** is employed, the length of short fibers **(102)** formed from the fiber material **(101)** tends to become too short. Consequently, when a large number of short fibers **(102)** are accumulated on the upper surface of the mesh belt **(103)** or the like, there is the possibility that it becomes difficult for the short fibers **(102)** to twine together. The reason for the short fibers **(102)** formed by the aforesaid construction to result in having too short a fiber length is explainable as follows. It is possible to form short fibers **(102)** having a longer length if the fiber material **(101)** is finely segmentalized while causing the needle blades

(105) to "bite" firmly into the material **(101)**; however, if such a "biting" action is insufficient, the cutting action of the needle blades **(105)** on the fiber material **(101)** within the casing **(107)** increases.

Bearing in mind these problems, the present invention was made. Accordingly, an object of the present invention is to make it possible to fabricate artificial cotton from short fibers which are intertwined sufficiently by providing an improved needle blade roll capable of forming short fibers which are longer in length than conventional.

DISCLOSURE OF INVENTION

The present invention is characterized in that each of needle blades **(14)** of a needle blade roll is inclined against the circumferential surface of a roll main body **(13)** so as to lie ahead with respect to the rotational direction of the roll main body **(13)**.

More specifically, an invention as set forth in claim 1 is directed to a needle blade roll for use in an artificial cotton fabricating apparatus **(1)** which fabricates artificial cotton by forming from a material **(2)** capable of formation of artificial cotton a large number of short fibers **(3)** ranging in fiber length between 1 and 200 mm and by accumulating the short fibers **(3)**, wherein the needle blade roll is mounted rotatably in a cylindrical casing **(11)** in order that a large number of short fibers **(3)** can be formed from the material **(2)**.

And, the needle blade roll is characterized in that it is made up of a roll main body **(13)** and a large number of needle blades **(14)** implanted into a peripheral surface of the roll main body **(13)** and that each needle blade **(14)** is arranged at a sloping angle relative to an associated radial line of the roll main body **(13)** so that its leading end lies ahead of the radial line with respect to the rotational direction of the roll main body **(13)**.

In the invention as set forth in claim 1, when the material **(2)** is fed through a clearance between the needle blade roll and the casing **(11)**, a large number of short fibers **(3)** are formed because the needle blade roll is rotated at high speed. In addition, the short

fibers **(3)** are dispersed in a wind channel and then are accumulated on a conveyor belt or the like while they are intertwined with one another, whereby artificial cotton is fabricated.

And, since each needle blade **(14)** is inclined relative to an associated radial line of the roll main body **(13)** so that its leading end lies ahead of the radial line with respect to the rotational direction of the roll main body **(13)**, this satisfactorily prolongs the length of time of the "biting" of the needle blades **(14)** into the material **(2)**, thereby weakening the action of cutting of the needle blades **(14)** on the material **(2)**. As a result, short fibers **(3)** formed from the material **(2)** have no longer a tendency to have too short a fiber length. Because of this, the short fibers **(3)** are formed, having a longer length dimension than conventional. Accordingly, when fabricating artificial cotton by accumulation of a large number of such short fibers **(3)**, the action of causing the short fibers **(3)** to be intertwined with one another is produced.

In addition, an invention as set forth in claim 2 according to the needle blade roll of claim 1 is characterized in that the needle blades **(14)** are implanted into the roll main body **(13)** so that the sloping angle (θ) relative to the radial line of the roll main body **(13)** falls in a range of $5° \leq \theta \leq 30°$.

If the sloping angle θ of each needle blade **(14)** to the radius of the roll main body **(13)** is not more than five degrees, then the action of cutting of the needle blades **(14)** on the material **(2)** increases and therefore the length of the short fibers **(3)** often results in becoming shorter. In the invention as set forth in claim 2, however, the cutting action is weakened. If the sloping angle θ exceeds thirty degrees, then the needle blade roll is likely to rotate at idle. In the invention as set forth in claim 2, however, such idling will not take place.

In addition, an invention as set forth in claim 3 according to the needle blade roll of either claim 1 or claim 2 is characterized in that the needle blades **(14)** are arranged in helical fashion on the peripheral surface of the roll main body **(13)**.

In the invention as set forth in claim 3, because of the arrangement that the needle blades **(14)** are arranged helically, the phase of each of the needle blades **(14)** deviates with respect to the direction in which the material **(2)** is fed, as a result of which the action of finely cutting the material **(2)** into a large number of short fibers **(3)** occurs uniformly all over the needle blade roll.

In addition, an invention as set forth in claim 4 according to the needle blade roll of either claim 1 or claim 2 is characterized in that the clearance (C) between the leading ends of the needle blades **(14)** of the roll main body **(13)** and an internal peripheral surface of the casing **(11)** falls in a range of $50\ \mu m \leq C \leq 500\ \mu m$.

If the clearance C falls below the lower limit of the above range, then there is the possibility that the needle blade roll **(12)** is brought to a stop by fiber jam. In the invention as set forth in claim 4, however, the aforesaid possibility is low. On the other hand, if the clearance C exceeds the upper limit of the above range, then the needle blade roll **(12)** is likely to rotate at idle. In the invention as set forth in claim 4, however, such idling will not take place.

Furthermore, inventions as set forth in claims 5-11 are characterized in that the material **(2)** is specified.

More specifically, an invention as set forth in claim 5 according to the invention of claim 1 is characterized in that the material **(2)** capable of formation of artificial cotton of the artificial cotton fabricating apparatus **(1)** is composed of at least one selected from the group consisting of synthetic resin, yarn, and sliver. In other words, the material **(2)** is composed of one of these materials or a combination of two or more of them.

In addition, an invention as set forth in claim 6 according to the invention of claim 1 is characterized in that the material **(2)** capable of formation of artificial cotton of the artificial cotton fabricating apparatus **(1)** is a synthetic resin.

In addition, an invention as set forth in claim 7 according to the invention of either claim 5 or claim 6 is characterized in that the synthetic resin comprises a fluoropolymer.

In addition, an invention as set forth in claim 8 according to the invention of claim 7 is characterized in that the fluoropolymer comprises polytetrafluoroethylene and/or an ethylene/tetrafluoroethylene copolymer.

In addition, an invention as set forth in claim 9 according to the invention of claim 8 is characterized in that the polytetrafluoroethylene and/or ethylene/tetrafluoroethylene copolymer comprises a uniaxial drawn substance.

In addition, an invention as set forth in claim 10 according to the invention of claim 5 is characterized in that the yarn comprises glass fibers or carbon fibers.

Finally, an invention as set forth in claim 11 according to the invention of claim 5 is characterized in that the sliver comprise aramid fibers, polyimide fibers, sheep wool, or various natural fibers.

Effects

In accordance with the invention as set forth in claim 1, each needle blade **(14)** of the needle blade roll is, on the circumferential surface of the roll main body **(13)**, inclined against the radial line of the roll main body **(13)** so as to lie ahead relative to the rotational direction of the roll main body **(13)**. As a result of such arrangement, at the time when the material **(2)** capable of formation of artificial cotton is fed through the clearance C between the needle blade roll and the casing **(11)**, the "biting" of the needle blades **(14)** into the material **(2)** becomes sufficient, thereby forming short fibers **(3)** having a longer length than conventional. Accordingly, in the case where artificial cotton is fabricated by accumulation of a great number of short fibers **(3)**, the short fibers **(3)** are fully intertwined with one another, thereby making it possible to enhance the strength of the artificial cotton.

In addition, in accordance with the invention as set forth in claim 2, the needle blades **(14)** are inclinedly implanted into the roll main body **(13)** so that the sloping angle θ

of each needle blade **(14)** with respect to the radius of the needle blade roll falls in a range of $5° \leq \theta \leq 30°$. If the sloping angle θ is less than five degrees, the "biting" of the needle blades **(14)** into the material **(2)** is weakened and the length of fibers often results in becoming shorter, and if the sloping angle θ exceeds thirty degrees, the needle blade roll is likely to rotate at idle. The invention as set forth in clam 2 eliminates these drawbacks.

In addition, in accordance with the invention as set forth in claim 3, the needle blades **(14)** are arranged helically. As a result of such arrangement, the phase of each of the needle blades **(14)** deviates with respect to the direction in which the material **(2)** is fed, thereby making it possible to equalize segmentalization that each needle blade **(14)** performs on the material **(2)**.

Finally, in accordance with the invention as set forth in claim 4, it is arranged such that the clearance C between the leading end of each of the needle blades **(14)** of the roll main body **(13)** and the internal peripheral surface of the casing **(11)** falls in a range of 50 $\mu m \leq C \leq 500$. If the clearance C falls below the lower limit of the range, then there is the possibility that the needle blade roll **(12)** is brought to a stop by fiber jam. In the invention as set forth in claim 4, however, the aforesaid possibility is low. If the clearance C exceeds the upper limit of the range, then the needle blade roll **(12)** is likely to rotate at idle. In the invention as set forth in claim 4, however, such idling will not take place.

BRIEF DESCRIPTION OF DRAWINGS

Figure **1** is a perspective illustration showing a general arrangement of an artificial cotton fabricating apparatus according to a first embodiment of the present invention;

Figure **2** is an axial cross-sectional view of a roll unit;

Figure **3** is an axial perpendicular cross-sectional view of the roll unit;

Figure **4** is a partially enlarged cross-sectional view of a needle blade roll;

Figure **5** is an outline view of the needle blade roll;

Figure **6** is an enlarged cross-sectional view of a wind channel and component parts on the periphery thereof;

Figure **7** is a cross-sectional view taken along line VII-VII of Figure **6**;

Figure **8** is a diagram depicting the flow of air in an upper portion of the wind channel;

Figure **9** is an enlarged view of a wind channel and its neighboring component parts in a first modification example of the first embodiment;

Figure **10** is a diagram depicting the flow of air in an upper portion of a wind channel in a second modification example of the first embodiment; and

Figure **11** is a schematic diagram showing an arrangement of a conventional artificial cotton fabricating apparatus.

BEST MODE FOR CARRYING OUT INVENTION

Hereinbelow, an embodiment of the present invention will be described in detail with reference to the drawings.

General Structure

Figure **1** is a perspective view showing a general arrangement of an artificial cotton fabricating apparatus **(1)**. In the apparatus **(1)**, many (numerous) short fibers **(3)** are formed from a material **(2)** (hereinafter referred to as a "fiber material") capable of formation of artificial cotton. While the short fibers **(3)** are accumulated on a paper base material (a base paper sheet **(20)**), the base paper sheet **(20)** is moved in its plane direction. In this way, artificial cotton is fabricated in succession.

The artificial cotton fabricating apparatus **(1)** is made up of a roll unit **(10)** for forming a large number of short fibers **(3)** from the fiber material **(2)**, a base paper sheet **(20)** serving as an accumulation surface member for accumulating the short fibers **(3)** under the roll unit **(10)**, a wind channel **(30)** which communicates from the roll unit **(10)** onto the base paper sheet **(20)** and which is air-sucked from below the base paper sheet

(20), and a forwarding mechanism **(40)** for continuously forwarding the base paper sheet **(20)** in its plane direction. In addition to these component parts, the artificial cotton fabricating apparatus **(1)** further includes other component parts, i.e., a material supplying mechanism **(50)** for supplying the roll unit **(10)** with the fiber material **(2)**, an air discharge mechanism **(60)** for performing suction of air from the wind channel **(30)** by forced air discharge under the base paper sheet **(20)**, and a take-up mechanism **(70)** for artificial cotton fabricated.

Material Supplying Mechanism

The material supplying mechanism **(50)** supplies the fiber material **(2)** in the form of a yarn or sliver to the roll unit **(10)**. The material supplying mechanism **(50)** has a plurality of bobbins **(51)** on which respective fiber materials **(2)** are wound, guide rolls **(52, 53)** for guiding the plurality of the fiber materials **(2)** to the roll unit **(10)**, and nip rolls **(54, 55)** which are arranged vertically so that the fiber materials **(2)** are compressed tightly therebetween. The nip rolls **(54, 55)** are brought into pressure contact with each other. When the nip rolls **(54, 55)** are rotationally driven, they perform an operation of pushing the fiber materials **(2)** into the roll unit **(10)**.

Fiber Material

At least one of synthetic resin, yarn, and sliver can be selected for use as the fiber material **(2)**. Of these materials, fluoropolymer can be employed as the synthetic resin. As the fluoropolymer, polytetrafluoroethylene (PTFE) and/or ethylene/tetrafluoroethylene copolymer (ETFE) can be employed. PTFE and/or ETFE can be formed of a uniaxial drawn substance. The film thickness of the fiber material **(2)** is about 30 μm.

The fiber material **(2)** may be formed entirely of PTFE fibers. Alternatively, it may be arranged such that some of the fiber materials **(2)** are PTFE fibers and the remaining is a different type of fiber. In other words, PTFE-fiber bobbins **(51)** and bobbins **(51)** for a different type of fiber may be employed mixedly. In addition, instead of using PTFE fibers,

it is possible to employ ethylene/tetrafluoroethylene copolymer (ETFE) fibers. In such a case, all the fiber materials may be ETFE fibers. Alternatively, it may be arranged such that some of the fiber materials **(2)** are ETFE fibers and the remaining is a different type of fiber.

As the different type of fiber, a yarn formed of glass or carbon fibers or a sliver formed of aramid fibers, polyimide fibers, sheep wool, or various natural fibers may be available. The reason for employing a sliver of natural fibers is explained as follows. For the case of cotton (or wool), its single fiber has a length of less than 10 cm at longest and, in order to make it possible to deal with this continuously, fibers are dealt with as a bundle (sliver) of fibers slightly twisted while arranging the fibers in the same direction. In addition, the reason for employing a sliver of aramid or polyimide fibers is explained as follows. Aramid and polyimide fibers are those that have a higher strength in comparison with other synthetic resins, so that it is preferable that they are precut into short fibers of about 50 mm and are dealt with after being reshaped into a sliver for the reduction in load on the needle blades and for the achievement of uniform stirring. On the other hand, industrial fibers such as glass fiber, carbon fiber et cetera are supplied to the apparatus in the form of a continuous yarn.

The aforesaid different type of fiber will be described in further detail, including the above-described example. Any one of inorganic fiber, heat-resisting synthetic fiber, polyolefin fiber, polyester fiber, and natural fiber or a combination of two or more of them may be employed.

As the inorganic fiber, for example carbon fiber, glass fiber, metallic fiber, asbestos, rock wool et cetera may be employed. In addition, as the metallic fiber, for example stainless steel fiber, copper fiber, steel fiber et cetera may be employed.

Furthermore, as the heat-resisting synthetic fiber, for example polyphenylene sulfide (PPS) fiber, polyimide (PI) fiber, aramid fiber (para-aramid fiber, meta-aramid

fiber), phenol fiber, polyarylate fiber, carbide fiber, fluorine-containing resin fiber et cetera may be employed. As the fluorine-containing resin fiber, for example tetrafluoroethylene-perfluoro (alkyl vinyl ether) copolymer (PFA) fiber, tetrafluoroethylene-hexafluoro propylene copolymer (FEP) fiber, polyvinyl fluoride (PVF) fiber, polyvinylidene fluoride (PVdF) fiber, polychlorotrifluoroethylene (PCTFE) fiber, ethylene-chlorotrifluoroethylene copolymer (ECTFE) fiber et cetera may be employed.

In addition, as the polyolefin fiber, for example polyethylene fiber, polypropylene fiber, nylon fiber, urethane fiber et cetera may be employed. Additionally, as the polyester fiber, for example polyethylene terephthalate fiber, polybutylene terephthalate fiber et cetera may be employed. Finally, as the natural fiber, for example wool, cotton, cashmere, angora, silk, linen, pulp et cetera may be employed.

Roll Unit

The roll unit **(10)**, as shown in Figure **2** which is an axial cross-sectional view and in Figure **3** which is an axial perpendicular cross-sectional view, is made up of a cylindrical casing **(11)** and a needle blade roll **(12)** as a roll member for formation of short fibers **(3)** which is housed in the inside of the casing **(11)**. The casing **(11)** is provided with a supply inlet **(11a)** for the fiber material **(2)** and a discharge outlet **(11b)** for the short fibers **(3)**, these openings being formed in a spaced apart relationship with each other in the circumferential direction. On the other hand, the needle blade roll **(12)** is provided with a roll main body **(13)** and a large number of needle blades **(14)** implanted into the peripheral surface of the roll main body **(13)**. The needle blade roll **(12)** is dimension-constructed so that a fine clearance is formed between the leading end of each needle blade **(14)** and the inner peripheral surface of the casing **(11)**. And, the roll unit **(10)** breaks the fiber material **(2)** supplied from the supply inlet **(11a)** into a large number of short fibers **(3)** by rotation of the needle blade roll **(12)** and discharges them through the discharge outlet **(11b)**.

Representation of the needle blades **(14)** is omitted in Figure **2**. Figure **3** shows only some of the needle blades **(14)**.

The casing **(11)** has an upper casing **(11c)** and a lower casing **(11d)**. The upper and lower casings **(11c)** and **(11d)** constitute an upper and a lower portion of a single cylindrical tube, respectively. In addition, in Figure **3** the supply inlet **(11a)** is formed in a left side portion of the cylindrical tube while the discharge outlet **(11b)** is formed in a right-side portion thereof.

The roll main body **(13)** of the needle blade roll **(12)** is made up of an external cylinder **(13a)**, an internal cylinder **(13b)**, a shaft **(13c)** which is the central axis of rotation of the external and internal cylinders, and a circular plate **(13d)** connecting the external cylinder **(13a)**, the internal cylinder **(13b)**, and the shaft **(13c)**, wherein these components are united together into a single unit, i.e., the roll main body **(13)**.

Bearing plates **(11e)** and **(11f)** are mounted at both ends of the upper and lower casings **(11c)** and **(11d)**. Ball bearings **(15, 15)** are mounted on associated bearing plates **(11e, 11f)** so that the ball bearings **(15, 15)** engage the shaft **(13c)** and rotatably support the needle blade roll **(12)**. The bearing plates **(11e, 11f)** are provided with respective retainer **(16a, 16b)** for preventing the slipping-off of the ball bearings **(15, 15)**. In addition, a bearing nut **(17)** is mounted onto the shaft **(13c)** on the assembly side of the roll unit **(10)** (the left-hand side in the figure). A pulley **(18)** is mounted at one end of the shaft **(13c)** and the needle blade roll **(12)** is rotated when the belt is driven.

As shown in detail in Figure **4**, the needle blades **(14)** of the needle blade roll **(12)** are implanted into the external cylinder **(13a)** of the roll main body **(13)**. Each needle blade **(14)** is inclined forward relative to a radial line of the roll main body **(13)** so that its leading end lies behind the radial line with respect to the rotational direction of the roll main body **(13)**. More specifically, the angle of sloping of each needle blade **(14)** with respect to an associated radial line of the roll main body **(13)**, θ, falls in a range of $5° \leq \theta \leq$

30°. More preferably it is set such that $\theta = 20°$. The lower limit of the angle range is determined for the reason that if the sloping angle (θ) is less than it this makes it difficult for the needle blades **(14)** to "bite" firmly into the fiber material. On the other hand, the upper limit is determined for the reason that if the sloping angle (θ) exceeds it the needle blade roll **(12)** tends to rotate at idle in the casing **(11)**.

Furthermore, the needle blades **(14)** are arranged equally in the circumferential direction of the roll main body **(13)** at such a pitch that the central angle (α) is 4°. In other words, the needle blades **(14)** are disposed at positions as a result of dividing the circumference of the roll main body **(13)** into 90 equal parts. Furthermore, as shown in Figure **5**, the needle blades **(14)** are arranged continuously in helical fashion at a given very small torsional angle (β) on the peripheral surface of the roll main body **(13)**.

The internal cylinder **(13b)** is formed by an iron tube. In addition, the needle blades **(14)** are made of steel material. Furthermore, the external cylinder **(13a)** is formed by a brass tube because of its workability for the implanting of the needle blades **(14)** and resistant to rust.

For example, the needle blades **(14)** are those shaped like a thin circular cone as a whole (see Figure **4**) having a base diameter of 0.9 mm and an overall length of 9 mm. Alternatively, the needle blades **(14)** are those shaped, as a whole, like a cylinder with a pointed part on the top (not shown). The needle blade roll **(12)** is formed such that it has a diameter of 100 mm (at the leading ends of the needle blades **(14)**) and an axial length of 200 mm. In addition, the outer diameter of the external cylinder **(13a)** is for example 93 mm and the amount of projection of the needle blades **(14)** in the radial direction of the needle blade roll **(12)** is set to 3.5 mm.

And, with respect to the needle blade roll **(12)** thus dimension-constructed, the casing **(11)** is constructed as follows. That is, $50\ \mu m \leq C \leq 500\ \mu m$ (more preferably $C = 200\ \mu m$) where C is the clearance defined between the inner peripheral surface of the

casing **(11)** and the leading end of each needle blade **(14)** (see Figure **4**). The lower limit of the range is determined in view of the possibility that the needle blade roll **(12)** is stopped by fiber jam if the clearance C is less than the lower limit. On the other hand, the upper limit of the range is determined in view of the fact that the needle blade roll **(12)** is likely to rotate at idle if the clearance C exceeds the upper limit.

In the above-described configuration, $L/R = 3.5/46.5 = 0.075$ where the radius of the external cylinder **(13a)** is R and the projection amount of the needle blades **(14)** is L; however, it may be arranged such that the projection amount L is varied within a range of from 2.0 to 5.0 so that L/R falls in a range of $2.0/46.5 \leq L/R \leq 5.0/46.5$. The reason for this is explained as follows. If L/R is less than the lower limit of the range, then the needle blade roll **(12)** tends to rotate at idle in the casing **(11)**. On the other hand, if L/R exceeds the upper limit of the range, then there is the possibility that the needle blade **(14)** is broken.

The needle blade roll **(12)** is so constructed as to rotate at a rotational speed of from 5000 to 10000 min^{-1}. And, when the needle blade roll **(12)** dimension-constructed as above rotates in the casing **(11)** at such a high speed, a large number of short fibers **(3)** (fiber diameter: about 12 μm; length: about 16 mm, on the average) are formed from the fiber material **(2)**.

The foregoing dimension configurations and so on are shown only by way of example. Therefore, adequate modifications thereon is possible depending on the apparatus configuration. In addition, although in some cases the short fibers **(3)** are formed having different fiber lengths according to the fiber diameter and the material, it suffices if the fiber length falls roughly within a range of from 1 to 200 mm.

Accumulation Surface Member, Forwarding Mechanism, and Take-Up Mechanism

In the present embodiment, the base paper sheet **(20)** serves as an accumulation surface member by which short fibers **(3)** discharged from the discharge outlet **(11b)** of the casing **(11)** are accumulated below the roll unit **(10)**. The base paper sheet **(20)**, made of a

paper base material having the property of being permeable to air, is fed to the apparatus **(1)** from a base paper roll **(21)** and is collected, after completion of the fabrication of artificial cotton on the surface thereof, by a take-up roll **(70)** as a take-up mechanism.

In the present embodiment, the take-up roll **(70)** and the base paper roll **(21)** serve as a driving roll and as a driven roll, respectively. In addition, between the base paper roll **(21)** and the take-up roll **(70)**, a plurality of nip rolls **(41)** are provided on the upper side while a traveling guide conveyor **(43)** formed by an endless mesh belt **(42)** is provided on the lower side. By such arrangement, the forwarding mechanism **(40)**, by which the base paper sheet **(20)** is guided while being moved, is constructed.

The five nip rolls **(41)** shown in the figure are arranged such that they are brought into press contact with each other. These nip rolls **(41)** are configured such that the base paper sheet **(20)** on which a large number of short fibers **(3)** are accumulated passes sequentially between vertically neighboring nip rolls **(41)** from below while being turned over sequentially along the surfaces of the lower four nip rolls **(41)**. Having passed through between the last two nip rolls **(41)**, the base paper sheet **(20)** is collected by the take-up roll **(70)** by way of a guide roll **(45)**.

The traveling guide conveyor **(43)** is constructed so that the endless mesh belt **(42)** is made to continuously go around in orbit by five rollers **(44)**. For example, these five rollers **(44)** are a driving roller, three driven rollers, and a roller with a tension. The traveling guide conveyor **(43)** is configured so that the endless mesh belt **(42)** travels at the same speed as the base paper sheet **(20)** while the base paper sheet **(20)** is guided.

Wind Channel and Air Discharge Mechanism

Figure **6** is an enlarged cross-sectional view of the wind channel **(30)** and its peripheral portions. Figure **7** is a cross-sectional view taken along line VII-VII of Figure **6**. In Figure **6**, the traveling guide conveyor **(43)** is represented in a simplified manner.

The wind channel **(30)** and the air discharge mechanism **(60)** are arranged vertically, facing each other across the base paper sheet **(20)** and the endless mesh belt **(42)**. The wind channel **(30)** and the air discharge mechanism **(60)** substantially communicate with each other. The wind channel **(30)** is shaped like substantially a rectangle in cross section defined by a front plate **(30a)** situated on the side at which the base paper sheet **(20)** is fed, a rear plate **(30b)** situated opposite to the front plate **(30a)**, and side plates **(30c, 30d)** in junction with ends of the front and rear plates **(30a)** and **(30b)**; note that in Figure **1** representation of the side plate **(30d)** on the near side is omitted. In addition, the air discharge mechanism **(60)** is provided, at its upper end, with a duct **(61)** shaped like an opening which faces a lower end of the wind channel **(30)**. The air discharge mechanism **(60)** sucks air from the wind channel **(30)** by forced air discharge by an air discharge fan (not shown) and creates a downward current of air in the wind channel **(30)**.

At the lower end of the wind channel **(30)**, rollers **(31a, 31b)** which rotate while abutting on the base paper sheet **(20)** are provided on the front plate's **(30a)** side and on the rear plate's **(30b)** side, respectively. The roller **(31a)** on the side of the front plate **(30a)** has a function of preventing outside air from entering the wind channel **(30)**. On the other hand, the roller **(31b)** on the side of the rear plate **(30b)** has, in addition to a function of preventing the entrance of outside air, another function of holding down the short fibers **(3)** accumulated on the base paper sheet **(20)**. Furthermore, a rectification lattice **(62)** is provided at the opening portion of the upper end of the duct **(61)** of the air discharge mechanism **(60)**.

The roll unit **(10)** is fixed to the upper end of the front plate **(30a)** of the wind channel **(30)**, and the discharge outlet **(11b)** of the roll unit **(10)** opens to the inside of the wind channel **(30)**. The rear plate **(30b)** of the wind channel **(30)** is composed of a plate material thinner but longer in height than the front plate **(30a)**. A portion of the rear plate **(30b)** extending from its lower end to a point thereof at a slightly lower level than the

upper end of the front plate **(30a)** runs parallel with the front plate **(30a)** and a portion of the rear plate **(30b)** above the parallel portion is bent in such a direction that it is spaced away from the front plate **(30a)**.

The wind channel **(30)** is provided with a short fiber stirring plate **(32)** for achieving uniform dispersion of a large number of short fibers **(3)** discharged from the roll unit **(10)** in the wind channel **(30)**. The short fiber stirring plate **(32)** is a member having a width dimension corresponding to the internal dimension of the lateral side plates **(30c, 30d)** and its both ends are fixed to the side plates **(30c, 30d)**.

In addition, the short fiber stirring plate **(32)** is so formed as to have, in cross section, the shape of a flat T defined by a base plate portion **(33)** and a vortex flow creating plate **(34)** fixed to an underside of the base plate portion **(33)**. The short fiber stirring plate **(32)** is arranged diagonally in the inside of the wind channel **(30)**, and the vortex flow creating plate **(34)** is situated midway between an upper end **(33b)** and a lower end **(33a)** of the base plate portion **(33)**. Furthermore, in the short fiber stirring plate **(32)**, the lower end **(33a)** of the base plate portion **(33)** is in close proximity to the rear plate **(30b)** of the wind channel **(30)**, the upper end **(33b)** is situated above the roll unit **(10)**, and a leading end **(34a)** of the vortex flow creating plate **(34)** is in close proximity to the upper casing **(11c)** of the roll unit **(10)**. In this arrangement, the leading end **(34a)** of the vortex flow creating plate **(34)** is situated at a higher level than the lower end **(33a)** of the base plate portion **(33)**.

A main flow path on the rear plate's **(30b)** side and a sub flow path on the front plate's **(30a)** side are divisionally formed by the short fiber stirring plate in the inside of the wind channel **(30)**.

Running Operation

Hereinbelow, the running operation of the artificial cotton fabricating apparatus **(1)** will be described.

In the first place, in the material supplying mechanism **(50)**, a plurality of fiber materials **(2)** containing PTFE and ETFE fibers or these fibers together with other fibers are supplied from each bobbin **(51)** to the roll unit **(10)** via the guide rolls **(52, 53)** and the nip rolls **(54, 55)**. Each fiber material **(2)** is pushed into the casing **(11)** from the supply inlet **(11a)** of the casing **(11)** and flows between the lower casing **(11d)** and the needle blade roll **(12)** in the direction of the discharge outlet **(11b)**.

Although the film thickness of the fiber material **(2)** of PTFE and ETFE (about 30 μm) is sufficiently smaller than the clearance C (from 50 to 500 μm) between the casing **(11)** and the needle blade roll **(12)** and is also sufficiently smaller than the space between adjacent needle blades **(14)**, the fiber material **(2)** is cut into short fibers **(3)** having a fiber diameter of about 12 μm and an average length of about 16 mm by the needle blades **(14)**, because the needle blade roll **(12)** rotates at high speed. At that time, since the nip rolls **(54, 55)** rotate at low speed while the needle blade roll **(12)** rotates at high speed, the fiber material **(2)** is cut while being stretched and is strongly stirred in the clearance C, the short fibers **(3)** after cutting become slightly wrinkled.

The short fibers **(3)** are blown into the wind channel **(30)**. In the inside of the wind channel **(30)**, a downward current of air is created by forced air discharge in the air discharge mechanism **(60)** and the short fibers **(3)** ride this air current, are dispersed in the inside of the wind channel **(30)**, and are accumulated on the surface of the base paper sheet **(20)**.

Here, air sucked from above the wind channel **(30)** will pass through flow-restrictions in the main and sub flow paths. With respect to the short fiber stirring plate **(32)**, the main flow path is a flow path on the rear plate's **(30b)** side while the sub flow path is a flow path on the front plate's **(30a)** side (the roll unit's **(10)** side). In addition, since air sucked from above the wind channel **(30)** always passes through the two flow-restrictions, this causes the downstream negative pressure to become greater than

conventional, thereby creating relatively strong jet flows at the outlets of the flow-restrictions. And, the short fibers **(3)** are stirred uniformly in the wind channel **(30)** by the mutual action of the jet flows generated in the two areas. The generation of such strong jet flows also has to do with the increase in ventilation resistance between the vortex flow creating plate **(34)** and the roll unit **(10)** due to the bending of the flow of air caused by the vortex flow creating plate **(34)** being intersecting with an air flow in the sub flow path.

In addition, a vortex flow is created downstream of the flow-restriction on the side of the sub flow path by the action of blow-off air generated by the needle blade roll **(12)** rotating at high speed and a jet flow from the flow-restriction (see Figure **8** which indicates the flow of air). The vortex flow circulates and moves along the base plate portion **(33)** from below the vortex flow creating plate **(34)** and finally flows together with an air flow from the sub flow path. Accordingly, since air does not linger at the underside of the vortex flow creating plate **(34)** and the base plate portion **(33)**, the short fibers **(3)** does not linger either. Therefore, problems such as adhesion will not arise. Besides, the short fibers **(3)** are dispersed more uniformly within the wind channel **(3)** by the effect of being stirred by a vortex flow.

In addition, although there is created an upward current of blow-off air in the discharge outlet **(11b)** of the roll unit **(10)**, the short fibers **(3)** are not blown out of the apparatus by the upward current because of a strong jet flow generated from the flow-restriction of the sub flow path.

The large number of the short fibers **(3)** thus dispersed within the wind channel **(30)** ride a current of air and are conveyed. When the short fibers **(3)** reach the surface of the base paper sheet **(20)**, they are intertwined with one another while receiving the action of sucking forces from the air discharge mechanism **(60)** and are accumulated there. And, during the time that the base paper sheet **(20)** travels to the take-up roll **(70)** from the base paper roll **(21)**, the short fibers **(3)** accumulated on the surface of the base paper sheet **(20)**

are compression bonded together by the nip rolls **(41)** to form artificial cotton. Alternatively, the short fibers **(3)** may be thermo compression-bonded together by the nip rolls **(41)**. Before use, the base paper sheet **(20)** is detached from the artificial cotton fabricated.

Effects of Embodiment

In the present embodiment, the lower end **(33a)** of the base plate portion **(33)** of the short fiber stirring plate **(32)** is arranged close to the rear plate **(30b)** of the wind channel **(30)** and the leading end **(34a)** of the vortex flow creating plate **(34)** lies close to the roll unit **(10)**. As a result of such arrangement, a current of air flows through the two flow-restrictions while the air current is bend in a curve on the sub flow path side, thereby increasing negative pressure in the inside of the wind channel **(30)** thereby to create strong jet flows at the outlets of the flow-restrictions of the main and sub flow paths. Consequently, the short fibers **(3)** are stirred uniformly by the mutual action of the jet flows of the two flow-restrictions. Variations (deviations) in the short fibers **(3)** are suppressed in the wind channel **(30)**, thereby making it possible to fabricate artificial cotton which is uniform in "*Metsuke*" (mass per unit area).

In addition, on the side of the sub flow path, by virtue of a vortex flow resulting from the action of a current of air discharged from the roll unit **(10)** and the aforesaid jet flow, it becomes possible to prevent the short fibers **(3)** from lingering in the vicinity of the wall surface and from adhering to the wall surface. Furthermore, in the wind channel **(30)** the up-current of air is suppressed by a jet flow on the side of the roll unit **(10)**, and the short fibers **(3)** will no longer fly out of the apparatus.

Furthermore, since the short fiber stirring plate **(32)** is arranged at a slope so that its lower end **(33a)** opposite to the roll unit **(10)** is low-lying, this arrangement makes it possible to control the volume of air flowing on the side of the main flow path and the volume of air flowing on the side of the sub flow path by making a change in the sloping

angle. This therefore makes it possible to control the strength of a jet flow and the strength of a vortex flow with ease.

And, with respect to the needle blade roll **(12)**, if the needle blades **(14)** are implanted at right angles (along the radial direction) relative to the circumferential surface of the roll main body **(13)** or are inclined backwardly relative to the rotational direction, then the action of cutting of the needle blades **(14)** on the fiber material **(2)** within the casing **(11)** tends to increase. As a result, the length of short fibers **(3)** formed from the fiber material **(2)** becomes shorter, therefore arising the possibility that the intertwining of the short fibers **(3)** becomes difficult. In the present invention, however, each needle blade **(14)** is inclined against an associated radial line of the roll main body **(13)** so that its leading end lies ahead of the radial line with respect to the rotational direction of the needle blade roll **(12)**. As a result of such arrangement, the length of time of the "biting" of the needle blade **(14)** into the fiber material **(2)** is prolonged, thereby eliminating the tendency that the length of short fibers **(3)** becomes shorter. Accordingly, it is possible to provide short fibers **(3)** having a relatively longer length dimension, so that when fabricating artificial cotton by accumulation of a large number of short fibers **(3)** there is generated an action of causing the short fibers **(3)** to be intertwined sufficiently with one another. As the result of this, it becomes possible to fabricate artificial cotton superior in strength.

Modification Examples of Embodiment

Modification Example 1

Referring to Figure **9**, there is shown a modification example of the foregoing embodiment. In this example, the front-to-rear direction of the wind channel **(30)** is the reversal of the foregoing embodiment, and the roll unit **(10)** is fixed to the rear plate **(30b)**. And, the rear plate **(30b)** is formed by inverting a member identical with the front plate **(30a)** of the foregoing embodiment back and forth (horizontally relative to the figure). On the other hand, the front plate **(30a)** is formed by back and forth inversion of a member

identical with the rear plate **(30b)** of the forgoing embodiment. In addition, the short fiber stirring plate **(32)** is disposed at a symmetrical position with respect to the foregoing embodiment, and the lower end **(33a)** on the side of the surface **(30a)** facing the roll unit **(10)** is lower-lying than the end portion thereof on the side of the roll unit **(10)** and than the leading end **(34a)** of the vortex flow creating plate **(34)**, which is the same as the forgoing embodiment.

Other configurations and operation/working effects are the same as the aforesaid embodiment.

Modification Example 2

Referring to Figure **10**, there is shown a second modification example of the foregoing embodiment. In this example, in the casing **(11)** of the roll unit **(10)** the discharge outlet **(11b)** is widened towards the upper casing **(11c)**. And, a second vortex flow creating plate **(11g)** is fixed to an end of the upper casing **(11c)** on the side of the discharge outlet **(11b)**. The second vortex flow creating plate **(11g)** lies substantially parallel with the front plate **(30a)** of the wind channel **(30)**. In other words, in the second modification example, the second vortex flow creating plate **(11g)** is provided atop the roll unit **(10)** below an air inflow opening **(30e)** of the wind channel **(30)**.

The discharge outlet **(11b)** of the casing **(11)** is made wider as described above, thereby facilitating the discharge of short fibers **(3)** into the wind channel **(30)** even when short fibers **(3)** are being intertwined with the needle blade **(14)**. On the other hand, if the discharge outlet **(11b)** is just made wide, this arises the possibility that short fibers **(3)** discharged from the top of the discharge outlet **(11b)** flow out of the apparatus. In this example, however, the upper casing **(11c)** is provided with the second vortex flow creating plate **(11g)** and the vortex flow creating plate **(11g)** is disposed atop the roll unit **(10)**, underlying the air inflow opening **(30e)** of the wind channel **(30)**. As a result of such arrangement, short fibers **(3)** are sucked in a vortex flow created by the second vortex flow

creating plate **(11g)** on the wind channel's **(30)** side, they ride a current of air flowing through the sub flow path and are brought back into the wind channel **(30)**. This prevents the short fibers **(3)** from flying out of the apparatus.

INDUSTRIAL APPLICABILITY

As has been described above, the present invention is useful for a needle blade roll for artificial cotton fabricating apparatuses.